SSR1 Tuner studies

(work in progress)

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Overview

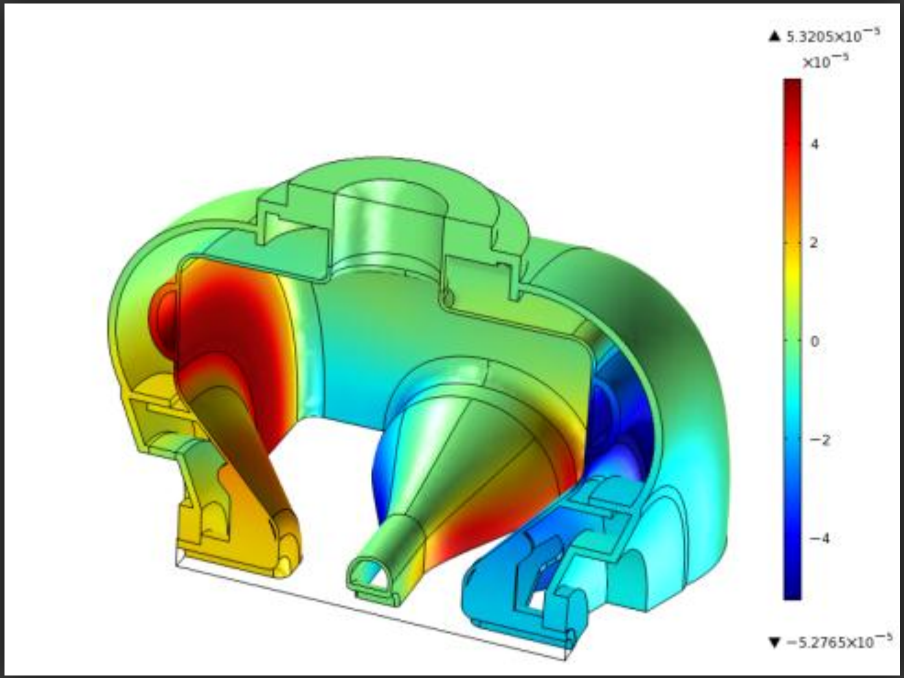
- Reduce the sensitivity to He pressure fluctuations of the system cavity+vessel+tuner.
- Allow access for maintenance to motor and piezos through access port
  - move piezos away from beam pipe
- Guarantee an acceptable tuning efficiency (stroke of beam pipe / stroke of motor+piezos, >50%).
  - High rigidity of tuner and/or low rigidity of cavity
  - Mechanical advantage as close to 1:1 as possible (we had 1:5 in the prototype)
- Guarantee an acceptable tuning Range (+/- 200 kHz)
  - Avoid yield
  - Limit the forces required

- Cavity + vessel design was developed for df/dP≈0
- The movable beam pipe (left in picture) was left free (conservative approach).

• Comsol multiphysics df/dp ~ 4.9 Hz/Torr

• Ansys multiphysics df/dp ~ -1 Hz/Torr

• Ansys mechanical
• df/dp ~ 2.6 Hz/Torr



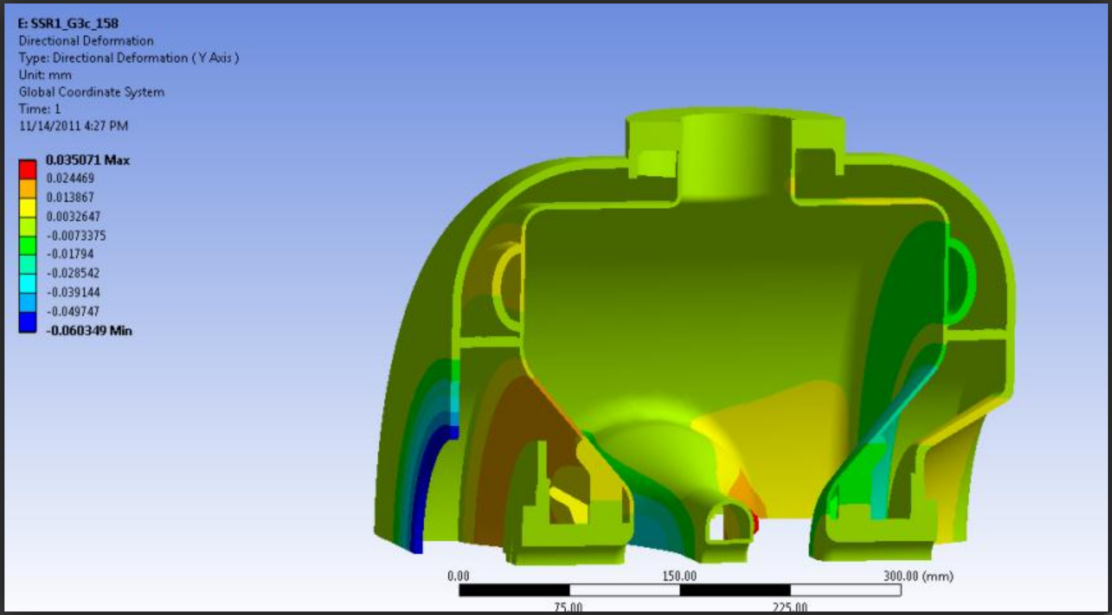
- A Ring couples the cavity end walls with the helium vessel end walls.

- The Diameter of the Ring has influence on several aspects.
- Of major importance is the robustness of the df/dP value, how stable it is for small variations of the actual cavity+vessel shape.
- We can predict (Passarelli) the df/dP value by looking at the deformations of the helium vessel at the connection points with the cavity (here called dRing and dBP).

- Ring D=125 mm, df/dP= -0.20 dRing – 0.53 dBP + 23 (Hz/torr)
- Ring D=140 mm, df/dP= -0.18 dRing – 0.52 dBP + 21 (Hz/torr)
- Ring D=158 mm, df/dP= -0.01 dRing – 0.29 dBP + 8.5 (Hz/torr)

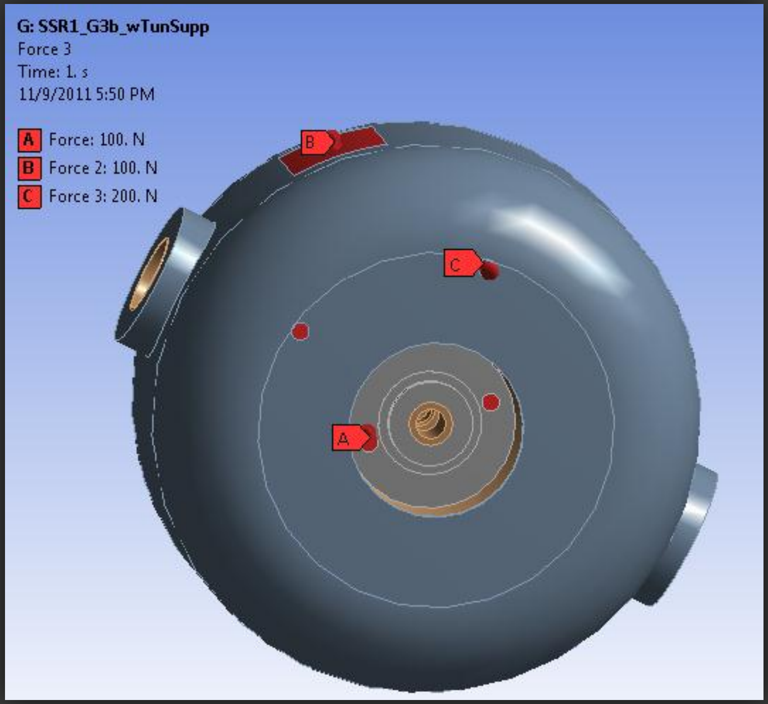
- Lower coefficients for deformations at the Ring and Beam Pipe give a more stable df/dP
- A larger Ring Diameter is favorable in this case

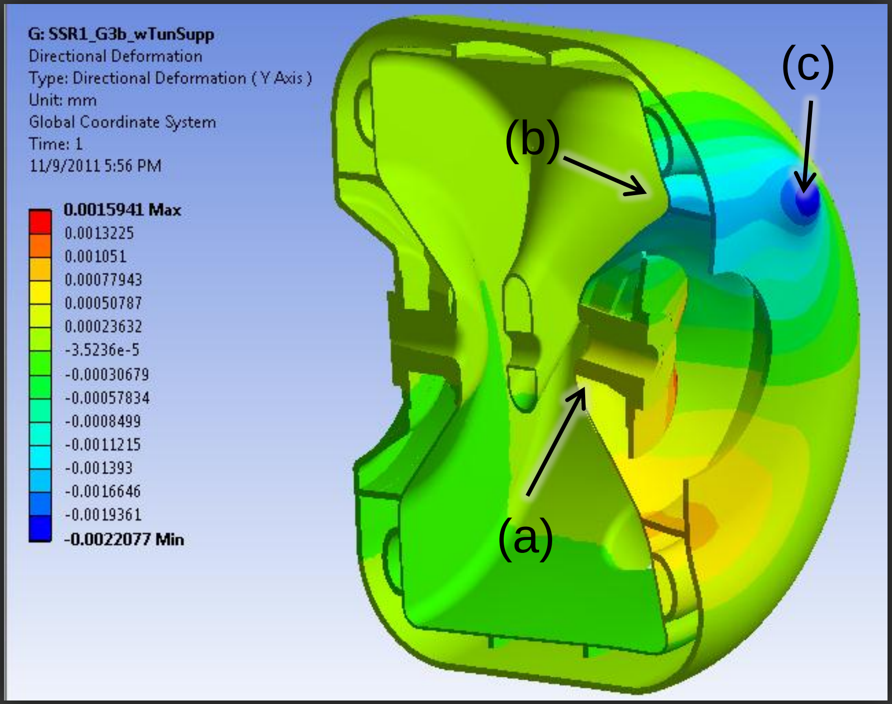
- Study with Ring D = 158 mm
- Df/dP = 5 Hz/torr (free BPs), 7 Hz/torr (fixed BPs)
  - And df/dP = -0.01 dRing – 0.29 dBP + 8.5 (Hz/torr)
- A Larger ring also reduces the stiffness of the cavity to tuning.



Deformations induced on the cavity+vessel with ring D=158 mm, due to 1 atm He pressure.
Beam pipes deformations in the order of few µm.

- If we introduce a tuner similar to the lever prototype, the cavity deforms in an unwanted way.
- The G3 vessel is more flexible than the prototype

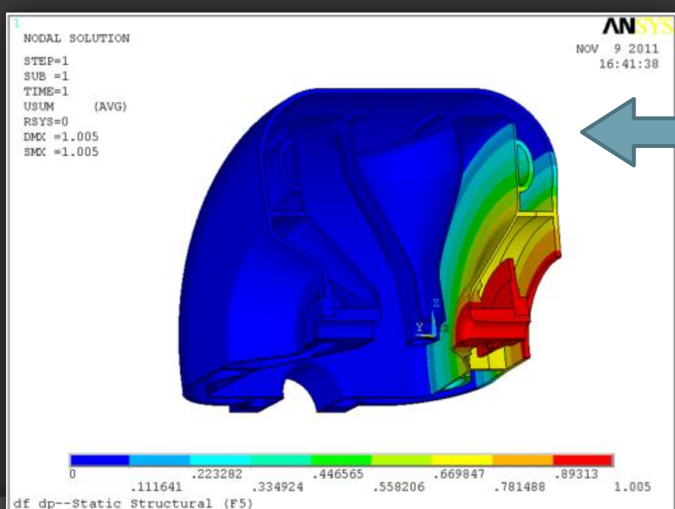


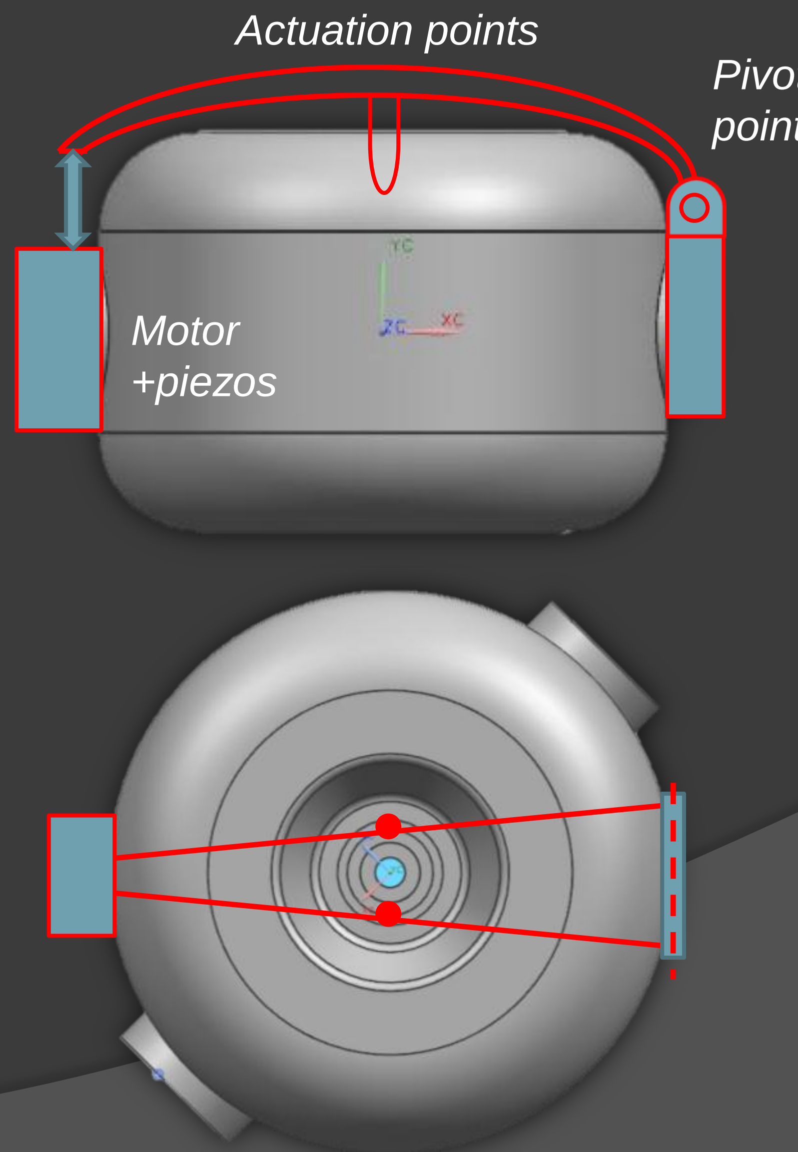


Interface areas:
A: tuning forces on cavity
B: motor reaction forces
C: pivoting point reaction forces

When subject to an arbitrary tuning force, the beam pipe area appears to rotate (a) more than translate.
Also, the end-wall shape is distorted (b) due to the reactions on the vessel wall (c)

- If we change the leverage layout for the tuner:
  - Translation of Beam Pipe
  - Mechanical advantage reduced to 1:2 (lower is better for piezo stroke requirements)
  - Reduced stiffness of cavity (increased tuning efficiency)
    - Vessel wall and cavity wall move in the same direction, the reaction forces do not “fight” the tuning forces





Ahead:

- Optimal diameter for the Ring, can we place it on top of the donut rib (how large can it be) before we see the df/dP diverging to negative values?
  - Easier welding
  - Lower stiffness to tuning
- Tuning forces on cavity+vessel, do they alter the df/dP?
  - If yes, can we minimize this effect by design?
- Tuner design
  - Identify the optimal interface locations
  - Evaluate the required stiffness of the lever arm to guarantee an acceptable tuning efficiency (beam pipe stroke/ motor+piezo stroke)